# ELECTRONIC APPARATUS CAPABLE OF EFFECTIVELY USING POWER OF AN AC/DC ADAPTOR

This application claims the benefit of Taiwan application Serial No. 92118536, filed July 7, 2003.

## BACKGROUND OF THE INVENTION

### Field of the Invention

**[0001]** The invention relates in general to an electronic apparatus, and more particularly to an electronic apparatus capable of effectively using power output by an AC/DC adaptor.

### Description of the Related Art

**[0002]** Typical electronic apparatus, such as a notebook computer, requires an AC/DC adaptor for supplying a DC power during its operation. Generally speaking, in addition to an in-constructed battery, the AC/DC adaptor is also an important power source for the electronic apparatus.

**[0003]** In the prior art, the AC/DC adaptor is designed to be capable of supplying the maximum consuming power of a notebook computer to ensure that the notebook computer can be manipulated normally at any condition.

[0004] As the operating frequency of the central processor unit (CPU) in the notebook computer is getting higher, the more power will be consumed, thereby requiring more power from the AC/DC adaptor. As a result, the volume and the weight of the AC/DC adaptor have to be increased accordingly. That will disobey the tendency of designing a notebook computer to be thin and small for carrying conveniently nowadays. For this reason, it becomes an important goal to use the AC/DC adaptor more effectively under the principle that devices are designed thin and small.

## SUMMARY OF THE INVENTION

[0005] It is therefore an object of the invention to provide an electronic apparatus capable of effectively using power of an AC/DC adaptor in order to reduce the volume and the weight of the AC/DC adaptor.

[0006] The invention achieves the above-identified objects by providing an electronic apparatus capable of effectively using power of an AC/DC adaptor including a host and an AC/DC adaptor. The AC/DC adaptor is used for receiving an AC power and converting it into a DC power for the host. At the same time, the AC/DC adaptor outputs a controlling signal to control the power consumption of the host according to the power output at that time. The AC/DC adaptor includes a switching power converter for converting the

AC power into the DC power, and a power supply controller for outputting a controlling signal according to the power output by the switching power converter.

**[0007]** Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** Figure 1 is a block diagram showing the electronic apparatus capable of effectively using power of an AC/DC adaptor according to a preferred embodiment of the invention;

**[0009]** Figure 2A is a circuit diagram of the AC/DC adaptor in Figure 1;

**[0010]** Figure 2B is a signal diagram of the power supply controller in Figure 1;

**[0011]** Figure 3 is a circuit diagram of the charging controller in Figure 1;

**[0012]** Figure 4A is a circuit diagram of the CPU controller in Figure 1;

[0013] Figure 4B is a timing diagram of the CPU controller in Figure 1.

## DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring to Figure 1, a block diagram of an electronic apparatus capable of effectively using power of an AC/DC adaptor according to a preferred embodiment of the invention is shown. The electronic apparatus includes an AC/DC adaptor 110 and a host 130. The AC/DC adaptor 110 receives an AC power and converts it into a DC power Vs supplied for the host 130. Moreover, the AC/DC adaptor 110 outputs a controlling signal CTRL to control the power consumption of the host 130 according to the power output at that time.

[0015] The AC/DC adaptor 110 includes a switching power converter 112 and a power supply controller 114. The switching power converter 112 is used for converting the AC power into the DC power Vs. The power supply controller 114 is used for outputting a controlling signal CTRL according to the power output by the switching power converter 112. If the present power output for the host 130 is too high, the power supply controller 114 will output the controlling signal CTRL to lower the power consumption of the host 130.

[0016] The host 130 includes a CPU 138, a CPU power converter 140, a CPU controller 135, a battery 136, a charging circuit 132, and a charging

controller 134. The CPU power converter 140 is used for converting the DC power output by the AC/DC adaptor 110 into the voltage required by the CPU 138. The battery 136 is used for supplying a DC power to the host 130. When the AC/DC power converter 140 supplies power for the host 130, it will also charge the battery 136 by way of the charging circuit 132. The controlling signal CTRL is electrically coupled with the CPU controller 135 and the charging controller 134 for controlling the power consumption of the CPU 138 and the battery 136 in the host 130.

**[0017]** The charging controller 134 adjusts the charging current supplied by the charging circuit 132 to the battery 136 according to the controlling signal CTRL. As the controlling signal CTRL shows the power consumption is too high, the charging controller 134 will reduce the charging current flowing from the charging circuit 132 to the battery 136 so as to save the power.

**[0018]** The CPU controller 135 adjusts the operating frequency of the CPU 138 according to the controlling signal CTRL. As the controlling signal CTRL shows the power consumption is too high, the CPU controller will slow down the operating frequency of the CPU 138 so as to save the power.

**[0019]** Referring to Figure 2A, a circuit diagram of the AC/DC adaptor 110 in Figure 1 is shown. The AC/DC adaptor 110 includes a switching power

converter 112 and a power supply controller 114. The switching power converter 112 receives the AC power at the input terminal, and outputs the DC power Vs accordingly. The inner circuit of the switching power converter 112 is a prior art that is not further illustrated in the text. The power supply controller 114 includes an operational amplifier OP, resistors R1, R2, R3, and capacitor C3. The operational amplifier OP includes a positive terminal for receiving the threshold voltage Vt, and a negative terminal for receiving the present reference voltage Vp. The power supply controller 114 outputs the controlling signal CTRL after comparing the present reference voltage Vp and the threshold voltage Vt. The threshold voltage Vt is predetermined according to the maximum power output by the AC/DC adaptor 110. For example, the threshold voltage Vt can be given by dividing the voltage Vs, the value of which can be determined by the resistor R2 as shown in Figure 2A. In addition, the present reference voltage Vp can be given by the voltage drop across the resistor R1 as the loading current Ip flows through the resistor R1. The resistor R3 and the capacitor C3 are used for determining the changing slope of the controlling signal CTRL at that time.

**[0020]** Referring to Figure 2B, a signal diagram of the power supply controller 114 in Figure 1 is shown. Take the output voltage Vs to be 19V and the maximum output power to be 95W as an example. The maximum

loading current of the AC/DC adaptor 110 is 95(W)/19(V) = 5 A. The threshold voltage Vt is predetermined to be 100 mV, so the value of the resistor R1 should be 0.02 Ω. As the loading current Ip of the AC/DC adaptor 110 is lower than 5A, the voltage across the resister R1 will be lower than 100mV, and the controlling signal CTRL will accordingly be at a high voltage level, which means the present power output is lower than the maximum output power. Therefore, it needs no further process for saving power. As the loading current Ip is higher than 5A, the output CTRL voltage of the operational amplifier OP will change from 5V to 0V, thereby lowering the controlling signal CTRL to a low voltage level, which means the output power is too high at that time. Therefore, a process for saving power will be carried out in the host 130. After the power consumed in the host 130 is lowered, the loading current Ip is reduced. As the loading current Ip is lower than 5A again, the output CTRL voltage of the operational amplifier OP will change from 0V to 5V, and thus the controlling signal CTRL will return to the high voltage level, where the changing slop is determined by the resistor R3 and the capacitor C3.

**[0021]** Referring to Figure 3, a circuit diagram of the charging controller 134 in Figure 1 is shown. The charging circuit 132, typically, has a controlling pin for controlling the charging current supplied for the battery 136,

so the controlling signal CTRL can be connected to the controlling pin directly. The charging controller 134 is a voltage dividing circuit including resistors R4, R5, and R6, for adjusting the charging current according to the voltage level of the controlling signal CTRL. For example, as the controlling signal CTRL is lowered to a low voltage level, the charging current from the charging circuit 132 will be accordingly reduced to save the power.

**[0022]** Referring to Figure 4A, a circuit diagram of the CPU controller 135 in Figure 1 is shown. The CPU 138 includes a pin for adjusting the operating frequency. The CPU 138 is operated at a high speed as the pin voltage is at a high level, and at a low speed as the pin voltage is at a low level. The CPU controller 135 includes an oscillation circuit 410 and a comparer CP. The comparer CP has a positive terminal for receiving the controlling signal CTRL, and a negative terminal for receiving the triangular wave T output by the oscillation circuit 410. According to the input signals, the comparer CP outputs an adjusting signal PW for adjusting the operating frequency of the CPU 138.

**[0023]** Referring to Figure 4B, a timing diagram of the CPU controller 135 in Figure 1 is shown. As the controlling signal CTRL is at the high voltage level, the adjusting signal PW maintains at a high voltage level so that the CPU 138 can be operated at a high speed. As the controlling signal CTRL is

getting lowered, the voltage level of the adjusting signal PW will be determined by comparing voltages of the controlling signal CTRL and the triangular wave T. For example, as the voltage level of the controlling signal CTRL is higher than that of the triangular wave T, the adjusting signal PW goes to a high level. As the voltage level of the controlling signal CTRL is lower than that of the triangular wave T, the adjusting signal PW maintains at a low level. For the controlling signal CTRL might have a higher level and a lower level than the triangular wave T by turns, the adjusting signal PW will correspondingly appear to be a pulse wave as shown in Figure 4B. The CPU 138 is operated at a high speed as the controlling signal CTRL has a high level, and at a low speed as the controlling signal CTRL has a low level. Therefore, the longer the adjusting signal PW maintains at the low level, the more power of the CPU 138 can be saved.

**[0024]** The advantages of the invention are:

**[0025]** (1) Owing that the power output by the AC/DC adaptor in the electronic apparatus can be adjusted automatically, various AC/DC adaptors having different output powers can be used in the electronic apparatus, thereby increasing its utilizing variety.

**[0026]** (2) The output power of the AC/DC adaptor can be designed at a

normal power level consumed by the electronic apparatus, without needs to be designed at the maximum consuming power.

**[0027]** (3) The power consumption of the host can be adjusted automatically, so the power of the AC/DC adaptor can be saved, and thus its volume and weight can be reduced.

**[0028]** While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.